

THE MUSCLES OF THE LIMBS OF THE RACCOON (*PROCYON LOTOR*).

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The genus *Procyon* is known to be one of the most ancient as well as one of the most generalized of the carnivora. The study of such a form when made in comparison with the more recent and more specialized genera, presents many features of interest. The following account of the muscles of the limbs has been undertaken with a view of ascertaining more especially what differences exist between these muscles and those of *Felis domesticus*,<sup>1</sup> and of man. Occasionally references to *Nasua fusca* were also made. Many variations in the human subject were found to correspond to the normal arrangement in *Procyon*. Since the subjects of nerve and muscle are intimately associated, not only anatomically but physiologically, it is stated from which nerve trunk each muscle derived its supply.

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## THE MUSCLES OF THE SUPERIOR EXTREMITY.

(a) *Extrinsic Set.*

The *Cephalo-humeral Muscle* is a broad, flat, fleshy muscle arising from the occiput at its crest for a distance of eight lines, and from the ligamentum nuchæ for one inch and a quarter, that is to say, for a distance equal to one-half the length of the dorsum of the neck. The muscle passes obliquely downward over the front of the shoulder, and is narrowed gradually to be inserted by fleshy fibres into the linear ridge on the anterior surface of the humerus. It blends with the tendon of the *Pectoralis Secundus*—and indeed may be said to be inserted by fleshy fibres upon the lower part of the fibrous portion of this muscle. A tendinous inscription passes through the muscle opposite the head of the humerus. Connected with the under surface of this inscription

<sup>1</sup>When the domestic cat is referred to in the text the word "Felis" is used.

is a stout fascia, which passes over the head of the humerus and is lost on the acromion and the metaacromion. This fascia embraces the lower third of the Levator Anguli Scapulae and appears slightly at the lateral aspect of the Cephalo-humeral muscle.

The rudimentary clavicle is in close relation with this muscle. The under surface of the bone is occupied by a stout membrane which passes downward and forward to the axilla, where it is lost on the fascia covering the Subscapularis muscle. This membrane seems to support the Supraspinatus muscle, and separates the nerves of the arm from those of the region of the Scapula.

*The Trapezius.*—The upper division arises from the occiput at the median third of the superior curved line, and from the ligamentum nuchae at its lower half. It is inserted upon the border of the spine of the scapula for its anterior three-fourths, and is continuous by an aponeurosis with the lower division over the remaining fourth. The lower division arises from the last cervical and the nine upper dorsal spinous processes, and is inserted directly upon the middle two fourths of the scapular spine, at the lower border, and indirectly (by reason of a union with the Infraspinatus aponeurosis) upon the remaining half of the spine. It is supplied by branches of the third and the fourth dorsal nerves.

*The Levator Claviculae* arises from the occiput beneath the origin of the Splenius, passes downward along the side of the neck to be inserted upon the under surface of the tendinous insertion of the Cephalo-humeral muscle for its entire length, as well as upon the clavicle for its entire length. Its nerve-supply is by branches of the first trunk of the brachial plexus.

*The Levator Anguli Scapulae* arises from the anterior half of the corresponding side of the body of the axis. It passes down the side of the neck to be inserted on the acromion, where its fibres are continuous with those of the Trapezius. It is supplied by branches from the first trunk of the brachial plexus.

The muscles usually called Trapezius and Levator Claviculae, in *Procyon* form parts of a single muscle, each of which bears to the whole a relation somewhat analogous to that which the different parts of the Pectoralis muscle bear to one another. As in the Pectoralis, they all influence the movement of the humerus, and like it many of the fibres are not inserted directly into the humerus, but indirectly through the advent of membranous, fibrous extensions.

But in addition to this the Levator Scapulae and at least one part of the Trapezius, are inserted into the spine of the scapula, while the Levator Anguli Scapulae, so called, is inserted into the acromion, so that the group is even less specialized than is the Pectoralis group, inasmuch as it is inserted into two bones of the anterior extremity, the scapula and the humerus. The Levator Anguli Scapulae becomes superficial between the Cephalo-humeral and the scapular fibres of the Trapezius, while the Levator Claviculae lies deep-seated beneath the Cephalo-humeral, and while being inserted at the tendinous inscription of the latter is in close relation to a thin fascial expansion that lies directly over the shoulder-joint. The Levator Anguli Scapulae and the Cephalo-humeral muscles in their turn terminate in part upon an aponeurosis which passes over the Deltoid muscle and is lost on the Infraspinatus, the Teres Major and the Triceps muscles, and with which the epitrochlear slip of the Latissimus Dorsi is in intimate association.

This single great muscle, therefore, can draw the scapula and the humerus forward; through its traction on the clavicle make tense the subscapular fascia; through the fibres of the Levator Anguli Scapulae make tense the sheath of the muscles of the extensor surface of the arm, and through the agency of the dorso-epitrochlear slip of the Latissimus Dorsi, the fascia of the rest of the upper extremity.

*The Rhomboideus* arises tendinously from the occiput seven lines from the median line. It arises, also, from the ligamentum nuchae its entire length, and from the five upper dorsal spines. It is inserted with the Serratus Magnus at the upper border of the scapula for nine lines. The posterior third of the fibres at the vertebral border are coarser than the remainder. Some of the fibres pass upward upon the dorsum of the scapula. It is supplied by branches of the cervical plexus at the middle of the lateral border.

*The Serratus Magnus* arises from the transverse processes of the fourth, the fifth, the sixth and the seventh cervical vertebrae and from the first seven ribs. It is inserted into the vertebral border of the scapula its entire length.<sup>1</sup> Its nerve-supply is from the long thoracic.

<sup>1</sup>The vertebral border is separable from the anterior by being twice its thickness, and in being limited anteriorly by the triangular base of the spine.

The *Latissimus Dorsi* arises from all the dorsal spines, from the vertebral aponeurosis, and from the twelfth, the thirteenth and the fourteenth ribs. It is inserted into a linear rugosity on the shaft of the humerus, placed to the median side of the deltoid ridge, and behind the tendon of the endo-pectoral portion of the Pectoral muscle. The dorso-epitrochlear slip equals in width the Latissimus at its insertion. It arises by a broad origin from the Latissimus, just prior to the formation of its tendon, and is tendinously inserted upon the median margin of the olecranon for its entire length. The internal dorso-epitrochlear slip seen in *Felis* is here absent. A long, slender slip of the ventral border of the Latissimus is inserted upon the central axillary tendon. It is supplied by numerous branches from the intercostal nerves, and at the axilla by a branch of the brachial plexus.

The *Pectoralis Major* muscle is divided into two portions. That portion which is superficial at the ventro-anterior aspect of the thorax (Ecto-pectoral of Wilder) arises from the sternum, a little more than one-half its length, also from an intermuscular septum between it and the muscle of the opposite side, extending thence four lines from the sternum along the median line of the neck. It is inserted into the deltoid ridge of the humerus, and into the triangular space lying between this ridge and the head of the bone. At its distal end this muscle is inserted with the Cephalo-humeral. This portion is fleshy throughout, except at the under surface at its insertion. It represents the *P. primus*, *P. secundus* and *P. quintus* of other mammals. An imperfect attempt is made at the separation of the *P. quintus*, but none of the *P. primus*.

That portion which is deep-seated at the ventro-anterior aspect of the thorax (Endo-pectoral of Wilder) embraces a broad and imperfectly differentiated sheet of fibres pertaining to the Panniculus, and to a sternal mass. The two divisions fuse intimately, so that they need not be separately described. They together represent the *P. quartus* of other mammals.

The usual plan of description of a muscle may here with propriety be reversed, and the insertion described before the origin. Lying beneath the fibres of insertion of the superficial portion of the muscle is a thin fibrous sheet that is attached to the deltoid ridge, to the median side of the insertion of the superficial portion. It extends from this line upwards over the scapular tendon of the Biceps, and is lost in the capsule of the

shoulder-joint and in the fascia over the coracoid process, as well as that beneath the Subscapular muscle. It passes downward beyond the ridge, where it receives a few fibres from the superficial portion and is lost in the antibrachial fascia.

It is nearly as broad as long, and in every part is distinct from the superficial portion of the Pectoral. In this description of the Pectoral group the membrane will receive the name of the *fibrous membrane of insertion or the central axillary tendon*.

The pannicular division of the deep mass arises as a broad sheet from the superficial fascia of the trunk, its dorsal portion from the sacrum to over the scapula, and the ventral portion from over the middle line of the thorax. Its fascicles converge toward the axilla, some of them fusing with the lower margin of the sternal sheet, and others ending on the posterior margin of the fibrous membrane of insertion. Others yet are inserted about the middle of the under (ventral) border of this membrane of insertion.—The sternal sheet arises from the sternum at the lower border of the superficial portion, which overlaps it, to the base of the ensiform cartilage, as well as from the subcutaneous tissue at the præcordium. It is a ribbon-shaped, fleshy muscle, and ends on the membrane of insertion by distinct fibres, and is continued over it to the deltoid ridge. These fibres are free from the membrane at the upper half of the line of insertion. Placed between the pannicular and the sternal sheets, a third fascicle is received, viz., a marginal slip from the Latissimus Dorsi.

Arising from the lower margin of the membrane of insertion, is the median dorso-epitrochlear slip. It fuses with the Trapezius at its distal half. It is inserted on the median margin of the olecranon, and contributes to the formation of the antibrachial fascia.

Muscular fibres thus approach the aponeurosis of insertion of the deep portion of the pectoral from the skin of the back and abdomen, from the sternum and from the Latissimus Dorsi. The lower margin of the membrane receives more fibres than the remaining portions, while the proximal parts receive none. The sternal sheet at its upper half tends to be specialized from the membrane, and throughout can be said to adduct the humerus. The pannicular sheet, together with the Latissimus slip, may be described as a tensor of the sheath of the Biceps and of the capsule of the shoulder-joint. The median dorso-epitrochlear slip protects the nerves of the upper arm.

*The Pectoralis Minor* (P. Tertius) arises from the second to the fifth costal cartilages inclusive, to the outer side of the sternum, and is inserted tendinously into the bicipital border of the great tuberosity of the humerus. It here forms the anterior part of the capsule, and is united with the Supraspinatus muscle. This muscle has been described in human anatomy as being inserted on the Supraspinatus, or as being continuous with it.

In *Procyon* no portion of either the Pectoralis Major or Pectoralis Secundus is inserted into the antebrachial fascia. The Pectorals are supplied by branches of the brachial plexus and of the intercostal nerves.

(b) *Intrinsic Set.*

*The Supraspinatus and the Infraspinatus Muscles* do not present sufficient points of difference as compared with the same muscles in other mammals to deserve special description. The Supraspinatus is, in great part, bilaminated, the interlaminar space tending to open forward. The origin of the Deltoid and the insertion of the Trapezius largely conceal the Infraspinatus. The nerves are received from the suprascapular nerve.

*The Subscapularis* is composed of three main sub-divisions. The most anterior of these arises from the anterior border of the scapula for its entire length, and the intermuscular septum between it and the Supraspinatus muscle. It is inserted into the humerus. It yields fibres of origin to the Coraco-Brachialis. Its fibres are parallel with those of the last-named muscle, and may be said to be physiologically in continuity with them. The tendons of the remaining subdivisions of the Subscapularis underlie the tendon of the first division.

The muscle is entirely free from insertion into the delicate capsule of the shoulder-joint. It is supplied by three nerves, each of which is a branch of the brachial plexus.

*The Teres Major* arises from the aponeurosis of the Infraspinatus, from the lower margin of the Subscapularis near the scapular angle, as well as from a small portion of the scapula at the upper end of the vertebral border. The muscle is tendinous where it overlies the humerus and is inserted beneath the Pectoralis Secundus, on the median side of the bicipital groove.

Directly back of the origin of the Teres Major lies the insertion of the Rhomboideus. The muscle is supplied by a branch of the brachial plexus.

*Teres Minor.*—This muscle is so intimately fused with the *Infraspinatus* as not to demand a separate description.

*Deltoid.*—The fascicle from the fascia over the *Infraspinatus* muscle joins the fascicle from the acromion at the distal half of the latter. The two fascicles thence continue as a single muscle to the humerus. The nerve-supply, which is from the anterior circumflex, is abundant. The most important fascicle would appear to be from the *Infraspinatus* fascia. The tendon receives the terminal fascicle on its outer surface, and its tendon of insertion lies in contact with the tendon of origin of the outer head of the *Triceps*.

*The Triceps* possesses four heads. The first arises from the scapula, as in man, by a thin tendon as broad as the muscular belly, and is inserted into the tip of the olecranon.

The second, or lateral humeral portion, from the lateral aspect of the neck of the humerus by a flat, thick tendon, one-fourth the greatest width of the belly. It is inserted into the tendon of the preceding, and into the olecranon on the lateral border, and into the ulna at its upper fourth, where it becomes continuous with the *Profound Flexor* as it arises from the posterior edge of the ulna. The second portion receives an accession of muscular fibres from the posterior median portion of the neck of the humerus. It joins the belly half way down the humerus.—The third portion arises by a flat, thin tendon from a median surface upon the humerus at its upper third. It merges in part with the small *Coraco-Brachialis*. It also arises from a distinct broad surface upon the border of the humerus between the epitrochlea and the upper border of the epitrochlear foramen. This slip is inserted into the olecranon and is merged with the origin of the *Flexor Carpi Ulnaris*. This is quite a frequent human anomaly.

The scapular head of the *Triceps*, with the internal humeral fasciuli, form parts of a single bilateral laminated sheet. The dorsal portion of this sheet is aponeurotic at and near the olecranon, and is continuous with the antebrachial fascia. The external humeral head from the proximal end is bilaminar one-half its entire length.<sup>1</sup>

<sup>1</sup> In *Felis* the internal humeral head is distinct from the scapular, and the bilaminar arrangement is in all parts of the muscle less evident than in *Procyon*.

*Nerve-Supply.*—The nerves of the Triceps enter the interlaminar spaces, there being one nerve for the scapular and the internal humeral heads, and a second for the external humeral head.

It is worthy of note that in *Procyon* the Triceps is inserted not only *behind* the elbow, but, by an aponeurosis, into the ulna in *front* of the elbow. Since the ulna cannot move and the insertion is chiefly on the lateral border, the bone, after being extended, is with the humerus rotated *inward* at the shoulder. In a word, the Triceps is an inward rotator of the entire extremity.

*Anconeus* arises upon the posterior surface of the humerus from the triangular space at the lower half of the bone. Its firmest attachment is on the lateral border. It also arises from the epicondyle, one line below the tip, directly to the outer side of the Extensor Carpi Ulnaris. Its fibres are inserted into the entire lateral surface of the olecranon, and the whole muscle keeps well to the lateral half of the joint. Nerve-supply: The long nerve to the Anconeus sends a branch to the external humeral head of the Triceps.

*Biceps Cubiti* arises by a single stout head from the coracoid process of the scapula. The muscle presents on the proximal half of both its anterior and posterior aspects a thin, glistening, fibrous surface, but at the distal half it is free from superficial fibrous tissue. The tendon of insertion is but one-third the length of the tendon of origin. It is inserted into the tubercle of the radius. This entire muscle is composed of a sheet which is so folded upon itself as to produce the effect of a pair of laminae, joined at the lateral border. Three separate branches from the brachial plexus enter the muscle in the interlaminar space, as well as a fourth, which, indeed, supplies the muscle, but since it lies in the position of the musculo-cutaneous trunk of *Felis* and most mammals, may be identified with this nerve. It does not, however, pierce either this muscle or the Coraco-Brachialis, as in man.

*Coraco-Brachialis* arises from the coracoid process by a narrow tendon which winds across the ventral surface of the tendon of the Subscapularis muscle. The muscle increases in width as it descends, and is inserted by fleshy fibres into the humerus distally to the tendon of the Latissimus Dorsi. The fibres of insertion are in close connection with the fibres of origin of the median head of the Triceps muscle. It receives a long slender nerve from the subscapular group of nerves from the brachial plexus.

*Brachialis Anticus* arises by penniform fleshy fasciculi from the entire lateral surface of the humerus. It lies in juxtaposition with the Biceps. No fibres whatever arise from the front or median surface. The upper fibres are nearly vertical and the lower nearly horizontal. Its tendon passes beneath that of the Biceps, and is inserted upon the median surface of the ulna, below the elbow-joint. The *Brachialis Anticus* keeps the ulna in contact with the trochlea, while the Biceps flexes the forearm. It also assists the Biceps in this movement and keeps the ulna within the tract of flexion.

The *Brachialis* does not arise from all the surface of the humerus which it covers; the muscular fibres are connected with the bone along the margins of the muscle only. The slips extend the entire length of the median, but for a shorter distance on the lateral margin. It is inserted upon a smooth surface on the median aspect of the ulna below the coronoid process. It is thus seen that this is chiefly a lateral muscle as related to the axis of the humerus, and by its insertion on the innermost and posterior portions of the two bones of the forearm, pursues an oblique direction as a whole, from the origin to the insertion. A variation in man consists in the union of this muscle with the *Supinator Longus*.

*Pronator Radii Teres.*—This muscle arises from the front of the epitrochlea, a surface which it exclusively occupies, the remaining flexors lying below it. It is aponeurotic in origin, inferiorly, and is wholly tendinous at its insertion. The distal border of the tendon reaches the middle of the shaft of the bone. The *Pronator* is to the radius what the *Brachialis Anticus* is to the ulna. The nerve-supply is derived from a small branch of the median nerve.

*Flexor Carpi Radialis* arises in common with the *Flexor Sublimis Digitorum*, and with the fine fasciculi with which it is intimately fused. It is inserted into the base of the second metacarpal bone, beneath the origin of the *Metacarpo-Phalangeal Flexors*. It receives its nerve-supply from the median nerve.

*Flexor Carpi Ulnaris* arises by two heads; the first arises from the depression on the median side of the olecranon, where it is continuous with the aponeurotic slip from the median humeral head of the *Triceps*, and is inserted by a long and narrow tendon into

the pisiform bone. The second head arises from the epitrochlea of the humerus, passes down parallel to the foregoing, and is inserted into the pisiform bone to the median side of the first portion. The second head also arises from the epitrochlea in common with the *Flexor Sublimis Digitorum*. The muscle lies entirely upon the *Flexor Profundus*, and does not touch the ulna. The nerve-supply of the first head is very minute, and confined to the extreme proximal end of the belly. That for the second head is larger, branches being received from the ulnar nerve at three different points along the proximal half of the belly.

It is evident that in *Procyon* the two divisions of the *Flexor Carpi Ulnaris* usually described are equivalent to distinct muscles. Unlike the arrangement seen in *Felis*, no attempt at fusion between the ulnar and humeral heads is seen, while the tendency for the humeral head to fuse with the superficial flexor is seen in both forms, though to a much less degree in *Procyon* than in *Felis*.<sup>1</sup>

*Palmaris Longus*.—The *Palmaris Longus* was double in one specimen, both portions arising in common with the *Flexor Sublimis Digitorum*.<sup>2</sup> In the other specimen it was found to be single, and the nerve-supply little or none.

*Flexor Sublimis Digitorum*.—This muscle arises from the epitrochlea. It soon divides into two portions. One of these passes without division to the *Flexor Profundus Digitorum*; the other, the main muscle, divides into two parts, one of which is inserted into the first and the second toes, and the other on the third and the fourth toes. The slips for the first and the second toes divide into two slips, one for each side of the sheath of the deep flexor at the first phalanx. In one specimen, the first toe received no slip.

The nerve-supply is from a small branch of the median nerve.

<sup>1</sup>The connection between the insertion of the muscle and the fifth metacarpal bone is much less decided than between the *Extensor Carpi Ulnaris* and the same bone. Such connection has been omitted as part of the essential description of the muscle.

<sup>2</sup>The Extensors lie successively along a ridge (supracondyloid ridge). The flexors are collected in a "bunch" at a process (not a ridge), the *Pronator Radii Teres* excepted. This muscle lies by itself above and in front of the "bunch."

The failure of the superficial flexor to support the sheaths of the third and fourth digits, may occur as an anomaly in man.<sup>1</sup>

*The Flexor Profundus Digitorum* arises in a penniform manner from the ulna, as follows: 1st, from the concavity on the median surface of the olecranon; 2d, from the posterior border of the ulna at the upper third; and 3d, from the median surface of the ulna at its middle third, near the distal end. The second portion derives some fibres from the membranous expanse of the Triceps on the lateral surface of the olecranon, and the intermuscular septum between it and the Extensor Indicis. Its tendons pass to the four outer toes. The under part of the tendon at the wrist is smooth.

Macalister<sup>2</sup> does not mention the union with the Triceps tendon. This might be found to vary in man. The nerve-supply of this muscle is from the median nerve.

*The Flexor Longus Pollicis* is composed of two separate portions, a superficial and a deep. The superficial portion arises in common with the Flexor Carpi Radialis from the epitrochlea. It is fleshy for the upper third of its course, and joins the Flexor Profundus Digitorum at the lower border of the annular ligament. Just prior to the formation of the tendon, muscular slips join the bellies of the Flexor Sublimis Digitorum and the Flexor Profundus Digitorum. Below the annular ligament the tendon for the thumb leaves the Profundus and passes to the second phalanx. From this tendon arises a Lumbrical muscle. A large slip passes from the fleshy portion to the tendon of the deep flexor just above the annular ligament.

The deep slip is penniform in character. It arises from the radius at its upper third, and joins the conjoined tendon at the upper border of the annular ligament. The last-named slip is evidently homologous with the anthropodean muscle of the same name. The nerve-supply is from the median.

It is interesting to note that the variations of this muscle in the human subject include in essential features the above arrangement. Mr. Carver<sup>3</sup> describes as arising partly from the Profundus

<sup>1</sup> In *Nasua fuscus* the slips of union between the superficial and the deep flexor are *three* in number, and are inserted on the conjoined tendon above the annular ligament. The union of the Sublimis with the Profundus occurs below the tendon.

<sup>2</sup> Trans. Royal Irish Acad., xv, 1872.

<sup>3</sup> Jour. of Anat. and Phys., iii, 260.

and partly from the Sublimis, a small muscle which became tendinous, and, just above the annular ligament, divided into two portions, one for the Flexor Pollicis, and one for the Profundus slip for the index finger. Excepting the slips from the Sublimis, this follows the plan in *Procyon*, the division in the latter occurring higher up. The lumbrical slip also is repeated as an anomaly in human myology (Wood and Macalister). The origin of the muscle from the epitrochlea, instead of from the radius, is a common human variation. The origin in common with the Flexor Carpi Radialis is, so far as I know, not repeated in man.

*The Extensores Carpi Radiales Longior et Brevior*, are as in man; the Brevior is the stronger of the two, and is confluent above with the Extensor Communis Digitorum.

It is supplied by the posterior muscular branch of the musculospiral nerve before it pierces the Supinator Brevis. The nerves spread on the under surface by short, single trunks at the proximal end.

*The Supinator Brevis* arises from the orbicular ligament by a narrow tendon, and is inserted upon the upper third of the radius. This is the arrangement in Gruber's Tensor Ligamentum Orbicularis Anterior of Man. He found it in fifteen cases in one hundred. This muscle is pierced by the posterior muscular branch of the musculospiral nerve, and receives from it its nerve-supply.

*The Supinator Longus*, much narrower than in *Felis*, arises muscularly from the upper end of the upper third of the Supracondyloid ridge, and is inserted tendinously upon the distal end of the radius. Its sparse nerve-supply is confined to a single small branch to the proximal end, derived from the posterior muscular branch of the musculospiral prior to its piercing the Supinator Brevis muscle.

*The Extensor Communis Digitorum* arises from the supracondyloid ridge between the Extensor Carpi Radialis Brevior, and the Extensor Minimi Digiti, and is in common therewith. It soon, however, separates from them, and, forming a tendon, divides beneath the annular ligament into four small tendons. These reunite upon the dorsum of the carpus to again separate and pass to the dorsal surface of the first phalanx of each toe. It is supplied from the posterior branch of the musculospiral nerve.

*Extensor Carpi Ulnaris* arises from the external condyle of

the humerus by a relatively broad tendon. The flat, weak belly terminates obliquely on a broad, stout tendon of insertion, which is attached to the lateral border of the pisiform bone at the base of the fifth metacarpal bone. The connection with the pisiform bone is more exact than in *Felis*, but in addition to fixing the pisiform the tendon seems to make tense the dorsal aponeurosis. It is largely ligamentous in action, and probably protects both the elbow and the wrist-joints.

*Nerve-Supply*.—Nerves are received on the median border by three distinct trunks. They are thus more numerous than those to the flexors of the carpus and of the fingers. The nerves arise from a little close network which also supplies the Extensor Communis Digitorum, and is derived from a branch of the musculo-spiral, which penetrates the Supinator Brevis.

*Extensor Ossi Metacarpi Pollicis* occupies the interval between the ulna and the radius, and arises from the proximal end of the distal half of the latter, and along the shaft of the former from the side of the olecranon to near the distal extremity. The muscle below the oblique ligament is penniform, the long oblique ulnar fibres joining the medianly-placed tendon, which winds around the distal third of the radius, lying in the pronounced groove at the wrist-joint, and is inserted into the median aspect of the proximal end of the first metacarpal bone. In one specimen the muscle was bi-penniform, the muscular fibres arising from the radius being inserted into the tendon to the median side. The weak nerve-supply of this muscle is derived from the posterior branch of the musculo-spiral, the nerves entering upon its upper free surface.

*The Extensor Minimi Digiti* arises from the supracondyloid ridge to the outer side of the preceding muscle, which it resembles in its general features, also from the orbicular and external lateral ligaments of the elbow-joint, and passes beneath the annular ligament by a distinct sheath, viz., over the distal end of the ulna. The tendons do not reunite after the first separation, but are inserted upon the lateral surfaces of the first phalanges of the three outer toes. The slip to the fifth toe is not distinct from the rest of the muscle as in *Felis*.<sup>1</sup>

<sup>1</sup>In *Nasua fasciata* the E. M. Digiti tends to unite with the Extensor Communis Digitorum, but subsequently separates therefrom before insertion.

*The Extensor Indicis* arises from the lateral aspect of the ulna just below the olecranon, and, for a slight distance, from the septum between it and the Flexor Profundus. Its tendon passes parallel to the ulna, and reaches the manus by running beneath the tendon of the Extensor Communis Digitorum beneath the annular ligament. The tendinous slips are inserted upon the first, the second and third fingers to the lateral side beneath the three tendons of the Extensor Communis. The muscle receives a tendinous slip from the Extensor Minimi Digiti, and is thus an abductor, and assists the Extensor Carpi Ulnaris and the Extensor Minimi Digiti. It receives two branches from the posterior muscular branch of the musculo-spiral nerve.

*Pronator Quadratus* extends from the middle of the forearm to the proximal border of the distal epiphysis of the radius and of the ulna. It is broader toward the wrist than toward the elbow where its fibres are pale and inconspicuous. The radial fibres are not concealed by the stout aponeurosis so conspicuous in *Felis*. The nerve-supply is from a deep branch of the interosseous.

*Palmaris Brevis* arises as a single slip from the annular ligament and is lost over the base of the fifth toe.

The Intrinsic Muscles of the Manus embrace the following:—

*The Opponens Hallucis*.—This insignificant fascicle arises from the fibrous tissue over the sheath of the Flexor Carpi Radialis, and is inserted into the proximal end of the first metacarpal bone. It is upon the same plane with some of the fibres of origin of the first Metacarpophalangeal Flexor.

*The Palmar Interossei*.—These muscles are three in number. The first and the third, passing respectively to the first phalanx of the hallux and the first phalanx of the annularis, are twice as broad as the second, which goes to the first phalanx of the index finger. These all arise from the fibrous tissue over the proximal ends of the metacarpal bones.

*Opponens Minimi Digiti* arises in common with these muscles to the lateral aspect, and is fused at its proximal third with the third muscle. It is inserted into the distal end of the metacarpal bone.

*Flexor Brevis Minimi Digiti* arises from the annular ligament and is inserted into the sheath of the Flexor Profundus Digitorum by a structure exactly similar to that found in the pes.

*Abductor Minimi Digiti* arises from the pisiform bone and ends by a long aponeurotic tendon upon the sheath of the first phalanx of the fifth toe in its lateral aspect. The muscle receives an accessory slip from the connective tissue beneath the deep flexor.

*The Metacarpo-Phalangeal Flexors.*—Each arises from the metacarpal bone of the corresponding toe and is inserted into the sesamoid bone of the metacarpo-phalangeal joint. The fifth toe alone possesses the Dorsal Interosseus, and even in this instance the muscle is in great part fused with the flexor muscle. For the remaining toes the Dorsal Interosseus is undifferentiated, yet latero-dorsal slips of tendon connect those parts of the flexor muscles seen from above in the intercarpal spaces, with the sides of the sheaths of the digits. As in the pes, so in the manus the divisions between the two portions of the flexors are more pronounced in the hallux and annularis than in the remaining toes.<sup>1</sup>

#### THE MUSCLES OF THE INFERIOR EXTREMITY.

##### (a) *Extrinsic Set.*

*Quadratus Lumborum.*—This muscle has not been differentiated from the vertebral series in *Procyon*. On the ventral aspect a flat slip is seen arising from the second lumbar vertebra on a line with the origin of the transverse abdominal muscle. It passes upward and outward to be inserted on the last rib at about its middle. A second flat slip, lying a little below the preceding, and on a deeper plane, appears to be a cleavage from the internal oblique abdominal muscle. It arises from the ventral aspect of the *Longissimus Dorsi*, and is inserted into the last rib at its

<sup>1</sup>The Lumbricales, Palmar and Dorsal Interossei muscles of *Procyon* may be described as inserted into the sheath of the digit. In the manus of the Macaque this was seen to be the case also. It will be remembered that in human anatomy the Dorsal Interossei are described as having their insertions into the extensor tendons of the digits as well as into the base of the first phalanx of each finger. It is probable that the simplest expressions of these muscles in mammals are as *tensors of the sheaths* of the digits on the dorsal and lateral surfaces, and that their connection with the tendons of the extensors of the fingers is not an essential one. Indeed the extensor tendons themselves may be said to end upon the same sheath, the latter being described as enveloping each digit like the fingerstall of a glove. It is free everywhere between the interphalangeal joints above and at the sides, but is closely incorporated with the capsules of the last-named joints as well as with the sheaths of the flexor tendons.

ventral third. These two slips are, perhaps, representative of the costal fibres of the Quadratus. The ilio-vertebral fibres are represented by an imperfectly differentiated slip, extending from the ventral aspect of the iliac crest to the transverse processes of the last lumbar vertebra.

*The Longissimus Dorsi* is very conspicuous from the ventral aspect of the trunk, and doubtless affords the generalized mass from which the Quadratus Lumborum of human anatomy has been evolved.<sup>1</sup>

*Psoas Minor* arises from the ventral surfaces of the bodies of the first three lumbar vertebræ, and is fused with the *Psoas Magnus*. It is inserted by a broad, glistening aponeurosis into a pronounced ridge of the ilium, directly above the ilio-pectineal eminence.

*Psoas Magnus* arises from the bodies of the third, fourth and fifth lumbar vertebræ, and the anterior surface of the corresponding transverse processes. After being joined by the *Iliacus Internus*, its tendon is inserted, after winding around the neck of the femur, into the trochanter minor. Both the *Psoas* muscles are perforated by a branch of the lumbar plexus, the *Psoas Magnus* being more particularly supplied by a number of short filaments from the anterior crural nerve.

*Iliacus Internus* arises by a long slip the entire length of the iliac fossa, and by a broad sheet of fibres extending across the venter of the ischium below the attachment of the ilio-lumbar fascicle of the Quadratus Lumborum, and also by a thin slip directly above the origin of the Rectus Femoris. The muscle is not confined to the pelvis. The anterior margin overlies the origin of the Tensor Vaginæ Femoris and of the Rectus Femoris. It is fused with the *Psoas Magnus* at the upper margin of the acetabulum.

The *Psoas Magnus* and the *Psoas Minor* unite with the vertebral mass, from which they are imperfectly differentiated, in forming a powerful vertebral flexor, which can be traced upward behind the pleura as far as the body of the ninth dorsal vertebra. The *Psoas Magnus* can be divided into several imperfectly defined laminae, the interspaces between which carry the branches of the lumbar and sacral plexuses.

<sup>1</sup> The muscle last named is here included, for while acknowledged to be a trunkal muscle it has important relations to the innominate bone.

*Gluteus Maximus*.—The *Gluteus Maximus* arises from the ilium, the vertebral aponeurosis, the lateral margin of the sacrum and the transverse process of the first caudal vertebra. The iliac origin is membranous, its under surface being in intimate union with the *Gluteus Medius*. The sacral origin is musculo-tendinous, as is that from the first caudal vertebra. The common sheet formed by the union of the two surfaces last named, affords origin for a slip of the Lateral Caudal muscle. The margins of the *Gluteus* are muscular throughout their entire length, but the muscle becomes tendinous as it overlies the trochanter major. It is in close connection if not continuous with the upper margin of the *Quadratus Femoris* at its insertion. The *Gluteus Maximus* is inserted into the third trochanter, which lies rather upon the anterior than upon the lateral surface of the femur, and by a well-defined slip into the fascia lata.

The anterior border of the *Gluteus Maximus* is inseparable from the corresponding border of the *Gluteus Minimus*.

The nerve-supply of the *Gluteus Maximus* is derived from branches piercing both the *Gluteus Medius* and the *Gluteus Minimus* near their anterior borders: the longest branch (arriving from the great sciatic nerve) lying on the under surface of the muscle, corresponding pretty accurately to that portion arising from the sacrum and the first caudal vertebra. In addition to these nerves the muscle receives several branches of the Inferior Gluteal nerve. The entire muscle easily resolves itself into two portions, which, however, cannot be separated by the knife. The anterior portion, of iliac origin, receives nerves by distinct Gluteal branches, and becoming fused with the *Gluteus Medius*, rotates the femur inward; while the posterior portion arises entirely from the sacrum and first caudal vertebra, fuses with the *Tenuissimus*, and, receiving the distinct and very long gluteal branch already mentioned, rotates the femur outward. The last-named muscular portion is extrinsic to the posterior extremity, while the first-named is intrinsic.<sup>1</sup>

<sup>1</sup> That portion of the *Gluteus Maximus* described as the second part in *Felis*, was not present in *Procyon*. The caudal or ventral origin of the *Biceps Femoris* would appear to compensate for its absence. The second part of the *Gluteus Maximus* of the cat is, in all probability, the same as the high origin of the *Biceps Flexor*, since it can be traced directly to the intermuscular septum between the *Vastus Externus* and the *Adductor Magnus*, and is continued thence to the capsule of the knee-joint.

*Gluteus Medius.*—The *Gluteus Medius* arises from the dorsum of the ilium, the under surface of the aponeurosis of the *G. Maximus*, and, by a separate set of fascicles, from the lateral border and the anterior surface of the sacrum. Fibres pass downward to be inserted into the great trochanter. Posteriorly this muscle is divisible into two planes which anteriorly are fused. The anterior portion is iliac in origin, and is inserted into the trochanter major. Superficially it is supplied by nerves in common with the *G. Minimus*. Its interior is fibrous. The posterior portion, slightly overlapped by the anterior, arises from the sacrum and is supplied by nerves passing directly from the sciatic at the great sacro-sciatic foramen. It is also supplied on the dorsal surface by a nerve escaping from the great sacro-sciatic foramen in common with the superior gluteal, but distinct from it. This portion of the *G. Medius* is inserted into the great trochanter as it borders on the digital fossa.

It is evident that a parallel can be here instituted between the *G. Maximus* and the *G. Medius*. The sacral part of each muscle can easily be distinguished from the iliac portion. In the case of the *G. Medius* the division has gone so far as to form the outline of two distinct muscles, but which are not completely separable the one from the other.

*Gluteus Minimus.*—The *Gluteus Minimus* arises from the dorsum of the ilium below that surface occupied by the *G. Medius*. It fuses anteriorly with the *G. Maximus*. This fusion enables the observer to classify the *G. Minimus* as a deep lamina of complex muscle, of which the *G. Maximus* is a superficial lamina, the two planes of cleavage being in this instance so remote from one another posteriorly, as to permit so large a muscle as the *G. Medius* to be received between them. The same disposition toward planal cleavage witnessed in the *G. Medius* is also found in the *G. Minimus*; the superficial lamina, however, is quite rudimentary, and is confined to the anterior fifth of the dorsal surface. Between the two laminae passes a large trunk from the superior Gluteal set of nerves which supplies both the *G. Medius*, *G. Minimus* and ultimately the anterior part of the *G. Maximus*. The *G. Minimus* is inserted in the anterior edge of the trochanter major by a narrow glistening tendon, and is in close relation to the hip-joint.

*Tensor Vaginae Femoris.*—The *Tensor Vaginae Femoris* arises

from the ventral edge of the ilium on a line with and immediately posterior to the Sartorius. It arises by a thin membranous tendon on a level with the great trochanter at the middle of the thigh, and ends in the fascia lata. It does not fuse with the muscles of the Gluteal group.

The structure last named is continuous with the fibres of insertion of the Biceps Femoris at the side of the knee, but is not in a line with the head of the tibia, but rather with the side of the patella. The nerve-supply is probably from the inferior gluteal; the dissection did not permit of an exact identification.

(b) *Intrinsic Set.*

*The Biceps Femoris.*—The Biceps Femoris arises by a broad stout aponeurosis from a spine of the sacrum,<sup>1</sup> and by a musculo-tendinous mass from the tuberosity of the ischium. The muscle forms a broad sheet of fibres over the outer side of the thigh and ends in a second aponeurosis at the lateral margin of the patella, and the head of the tibia. At a point about on a level with the head of the tibia, a slender fascicle is given off that passes over the leg superficially and joins the Soleus, and with the last-named muscle contributes to the formation of the Tendo-Achillis. Beneath the Biceps lies the Tenuissimus. This arises from the under surface of the Gluteus Maximus, and passing down over the sciatic nerve is lost over the fascia of the leg.

The Biceps was found in one dissection to present variation from the above description. The body of the muscle as it arose from the ischium divided into two portions, an anterior and a posterior. The anterior, larger—and at the ischium the more superficial portion—was inserted entirely upon the side of the patella and the external tibial condyle. The posterior portion became superficial about six lines below the tuberosity, and was inserted by a broad, thin surface on the fascia of the leg, and, finally, instead of joining the Soleus, was continuous with the Gastrocnemius at the beginning of the tendo-Achillis. The Tenuissimus instead of arising from the Gluteus Maximus, arose from its tendon of insertion into the third trochanter. It passed to the posterior division of the Biceps, along the hinder border of which it descended to the fascia of the leg.

<sup>1</sup> In *Ursus*, according to the figure in Cuvier and Lieutaud, this slip is absent.

An examination of the variations of the Biceps Femoris (Biceps Flexor Cruris) results in adapting the above description in its several parts to human anatomy. Sömmering describes the muscle with a second long head from the tuberosity of the ischium; Meekel with a third head from the upper portion of the linea aspera; Wood describes a head arising from the fascia beneath the Gluteus Maximus. This is evidently the same as the Tenuissimus. A slip continuous proximally to the sacrum, has been recorded by Theile and Macalister. A slip may be attached to the external condyle of the tibia. A slip may be inserted in the fascia of the leg, or one may join the tendo-Achillis.

It is further interesting to note that the muscle is variable in *Procyon* as well as in the human subject. In one specimen the Tenuissimus, which may be regarded as homologous with the femoral head of the human muscle, was attached to the femur, while it is commonly seen arising from the Gluteus Maximus. The fact last named would indicate that the muscle is of the same relative value as one of the muscular slips passing between a superficial and a deep muscle of the same group, as instanced in the fascicle occasionally seen passing between the superficial and the deep flexors of the fingers. It is supplied by a separate branch of the sciatic as well as by branches in common with the Biceps. The nerve-supply of the Biceps consists of great numbers of minute branches from the lesser sciatic and its anastomosis with the obturator nerve.

*The Semitendinosus.*—This muscle arises from the upper end of the tuberosity of the ischium, and by a fleshy slip from the posterior margin of the aponeurosis of the Biceps. The last-named slip joins the main belly at its upper third. The muscle is inserted on the anterior surface of the tibia at its upper third. Its tendon, as is usual, lies directly beneath the tendon of insertion of the Gracilis.

The Semitendinosus, while arising in great measure in common with the Biceps, is inserted on the opposite side of the limb. The nerve-supply is from the sciatic.

*The Semimembranosus* arises from the entire posterior margin of the innominate bone, excepting a portion a few lines in length near the symphysis, which is occupied by the origin of the Adductor Magnus. It forms in reality two muscles. The first of these —ischio-tibial—arises as a flat band of tendinous fibres from the

tuberosity of the ischium and is inserted into the tibia at the inner tuberosity. The second—the ischio-pubio-femoral—arises from the remaining portion of the posterior margin and is inserted into the femur above the external condyle. Uniting the two is a long fusiform slip, which arises from the ischium above and is inserted with the other division into the femur.

The nerves of the Semimembranosus are numerous and large. The ischio-tibial is supplied by a distinct trunk from the great sciatic nerve. The ischio-pubio-femoral by both this nerve and the obturator. A long branch of the nerve first named runs along the femoral division to its distal third, where it anastomoses with a branch of the anterior crural nerve.

*Sartorius*.—The Sartorius muscle arises from the anterior superior spinous process of the ilium, by a rough angulated border equalling in length one-third of the anterior border of the ilium, and from a fibrous membrane continuous with the External Oblique muscle of the abdomen. The muscle is broad and ribbon-shaped and is inserted into the capsule of the knee-joint toward its median surface, including the median border of the patella, and passing thence downward to the tibia, where it is inserted membranously on the anterior surface, for nearly one-half the length of the shaft. On the same plane, it is in intimate union with the insertion of the Gracilis. Beneath this plane lies the insertion of the Semitendinosus. The Sartorius is supplied at its upper third by the anterior crural nerve, and at its lower fifth by a deeper-seated branch from the same nerve.

*Gracilis*.—The Gracilis arises tendinously from the entire length of the symphysis, and muscularly by a thickened border from the descending ramus of the pubis. It is inserted at the median side of the patella, the median tuberosity of the tibia and the corresponding border of the tibia at its proximal third. It is freely supplied both at the proximal and the distal portions by branches of the anterior crural nerve.

*Adductor Magnus* arises from the lower half of the symphyseal line, the pubis at the beginning of the descending ramus and the under surface of the Gracilis. It is inserted by fleshy fibres into the entire posterior surface of the distal half of the femur. The fibres of insertion form three distinct fasciculi, one, representing the median cord that in the human subject, passes to the minute tubercle above the epiphysis, but which is here fleshy and dis-

tributed over the posterior surface. The remaining portions lie nearer the lateral margin, one of them directly upon it. The nerves are derived from the anterior crural and the obturator.

*Adductor Longus* arises from the symphysis and the pubic half of the ilio-pectineal line. It is inserted into the femur by an oblique line near the median border. It is supplied by nerves from the anterior crural.

*The Pectineus and the Adductor Brevis* arise from the ilio-pectineal line, but not from the bone between this line and the acetabulum. They are both inserted tendinously on the *A. Longus*, but nearer the lateral border. Their nerves are derived from the anterior crural.

*Quadriceps Extensor*.—The *Rectus* arises over the acetabulum by a single head. At its proximal seventh the muscle is tendinous and overlaid by the *Psoas*. It is free throughout, except at the lower fourth of the outer side, where it is joined by the *Vastus Externus*. It is protected by a sheath derived for the most part from the *Vastus Internus*. On this sheath is inserted the *Tensor Vaginae Femoris*.

The *Vastus Internus* and *Vastus Externus* form a continuous mass at the lower third of the thigh, behind the *Rectus*. They are free from the femur at its upper half; the *V. Internus* arises for the most part from the front of the shaft of the femur at the base of the trochanter minor, and by a continuous small fleshy line from the entire length of the front of the bone. It is continuous with the *Crureus*. The *V. Externus*, *V. Internus* and *Crureus* form a muscular bed which is fibrous at its lower half. The nerve-supply of the *Quadriceps Extensor* is derived from the anterior crural nerve. In addition the *Vastus Externus* receives four or five branches from the lesser sciatic nerve.

*Quadratus Femoris*.—The *Quadratus Femoris* is a stout muscle arising from the tuberosity and the ramus of the ischium, and inserted into the posterior surface of the femur by a rugose crescentic line. It is supplied by a distinct nerve from the great sciatic, which in proportion to the size of the muscle is unusually large.

*Obturator Externus*.—The *Obturator Externus* arises from the border of the obturator foramen externally, the descending ramus of the pubis and the ramus of the ischium, and passes forward to be inserted by a tendon which is superficial at its distal half

into the anterior half of the digital fossa. In the anterior part of the muscle is seen an imperfect attempt at the formation of two laminae. The tendon is here concealed to a greater degree than elsewhere. The muscle receives its nerve-supply from the obturator nerve.

*Obturator Internus.*—The Obturator Internus arises from the entire inner surface of the innominate bone for a distance equalling the extent of the symphysis pubis. Save at its extreme anterior margin and the trochlear surface as it winds round the border of the ischium, the muscle is fleshy throughout. Both Gemelli muscles are well developed and are fused in front of the main tendon. The muscle is intimately connected with the capsule of the hip-joint and is fused at the insertion with the tendon of the Obturator Externus. The Obturator Internus receives nerves within the pelvis from the internal pudic, and the Gemelli from a separate trunk destined for the Quadratus Femoris.

The Gemelli form a deep lamina of cleavage from the main mass of the Internal Obturator which represents a superficial layer of the same muscle.

*Gastrocnemius.*—This muscle arises from the femur by two heads. The outer head bears a sesamoid bone.—The fibrous tissue between the femur and this bone are exceedingly stout and coarsely fasciculated. A thin fascia-like membrane extends from the lateral surface of the capsule of the knee-joint to the superficies of the sesamoid. This is continuous with the Vastus Externus muscle, so that when traction is made upon the muscle last named the sesamoid can be moved slightly upward. This muscle, therefore, can aid in fixing the bone at times when the Gastrocnemius and the Plantaris contract. The bone is also supported by bands extending to it from the posterior surface of the capsule.—The outer head of the Gastrocnemius is pierced by a branch of the sciatic nerve to supply the Soleus on its superior surface. Fusing with the under surface of the outer head is the origin of the Plantaris muscle. The inner head is of muscular origin and ribbon-shaped, and is attached directly to the femur without the intervention of a sesamoid bone. The two heads of the muscle fuse at the upper third of the leg, forming a flat, triangular surface which gradually becomes tendinous toward the apex of the triangle to form the tendo-Achillis.<sup>1</sup> An unusually large bursa

<sup>1</sup> There is no slip of origin from the fascia over the head of the fibula as in *Felis*.

intervenes between the concave tuber calcis and the tendon. Under the head of the Biceps muscle it has already been mentioned that the Gastrocnemius may be reinforced by the lower part of this muscle.—The Soleus arises from the head of the fibula only, by a musculo-tendinous origin. It is fusiform, much thicker, and in every way more robust than the Gastrocnemius, and joins the tendo-Achillis six lines above the tuber calcis. The Soleus is fleshy throughout and does not receive any slip of the Biceps Flexor.—The nerve supply of the Gastrocnemius is from the sciatic. The Soleus also is supplied by a branch of the sciatic, passing between the Plantaris and the external head.

*Plantaris*.—Fusing as it does with the outer head of the Gastrocnemius, the Plantaris can be traced with scarcely any artificial dissection to the Sesamoid bone in the outer head of the Gastrocnemius. The surface of contact between the Plantaris and the Gastrocnemius is fibrous throughout. This is seen to be different from the arrangement in *Felis*, in which animal the Plantaris arises in part from the fascia of the leg. The Plantaris tendon becomes superficial to the outer side of the tendo-Achillis, passes over the calcaneum as a broad aponeurosis, from the distal end of which, on the plantar surface of the foot, the Flexor Brevis Digitorum arises. The motion between the Plantaris and the Flexor Brevis Digitorum is pronounced medianly but absent laterally. The Plantaris may thus be said to be inserted into the calcaneum on its lateral surface, and the Flexor Brevis Digitorum to arise from the same surface. On the median aspect, however, the two muscles are continuous with one another through intermediate fibrous tissue. It is supplied by the sciatic nerve.

*Popliteus* arises from a shallow pit on the lateral surface of the external condyle by a ligament-like tendon, that passes in a groove horizontally backward to the tibia. The muscular fibres are arranged in a thin sheet and are inserted into the tibia for its upper third. The proximal edge of the muscle is horizontal and in the same line with the tendon of origin. The distal edge is oblique and slightly overlaps the fascia covering the Flexor Longus Pollicis. The nerve supply is from the sciatic.

*Flexor Longus Digitorum* arises from the proximal half of the posterior surface of the tibia, and from the stout fascia lying on the posterior aspect of the muscle. The very stout, broad tendon formed at the middle of the leg, lies in a groove behind the inter-

nal malleolus in company with the small *Tibialis Posticus*, and is inserted on the median side of the conjoined tendon at the tarso-metatarsal line. It receives all the fibres of the *Musculus Accessorius*.

*Musculus Accessorius* arises from the lateral aspect of the calcaneum, and is inserted on the median half of the conjoined tendon.

*Flexor Longus Pollicis* arises from the proximal two-thirds of the posterior surface of the shaft of the fibula, and by nearly as long a surface from the tibia. The fibres of the tendon can be traced nearly to the head of the fibula but become free only at the level of the ankle. The tendon lies in the deep recess between the tibia and the fibula, in the pronounced groove on the posterior border of the astragalus, as well as in the depression beneath the *sustentaculum tali* to unite with the conjoined tendon at its lateral half. The conjoined tendon splits into five phalangeal slips, one for each of the five toes—each tendon being inserted into the plantar tubercle of the terminal phalanx.

*Lumbricales*.—These are three in number and are supplied to the second, third and fourth toes. The muscle for the first toe arises from the tendon of the long flexor of the second, that for the second from the tendon of the third toe, and that for the third from the tendon of the fourth toe. These slips are inserted on the sheath of the flexor tendons, which cannot be separated from the tendon of insertion of the *Extensor Longus Digitorum*.

*Tibialis Posticus* arises from the proximal ends of both the tibia and the fibula. It passes downward parallel to and in part concealed by the *Flexor Longus Digitorum*, in company with the tendon of which it enters a sheath behind the internal malleolus. It is inserted into the scaphoid bone. The posterior tibial group of muscles receives its nerves from the internal popliteal nerve as it passes between the two heads of the *Gastrocnemius*.

*Peroneus Longus* arises tendinously from the lateral surface of the head of the fibula, by a head that is slightly narrower than the belly. It becomes tendinous at the middle third of the leg, thence passes through a separate sheath over the external malleolus, it lies in a groove on the calcaneum beneath the *sustentaculum tali* and is inserted into the base of the fifth metatarsal bone.

*Peroneus Brevis* arises broad and fleshy from the posterior

surface of the fibula at its middle third. Its muscular fibres pass down as far as the external malleolus with the tendon, which is twice as broad as that of the *Peroneus Longus* and is inserted into the base of the dorsal surface of the fifth metatarsal bone. A slip from the tendon just before the insertion is continuous with the dorsal aponeurosis lying beneath the *Flexor Brevis Digitorum*. Traction on this sheet slightly extends the toes, a function best seen along the lateral border of the foot.—The nerve-supply is by a branch of the anterior tibial which extends nearly the entire length of this muscle.

*Peroneus Tertius* arises at the proximal third of the fibula by oblique, delicate, fleshy fibres. The tendon lies in the same groove on the posterior aspect of the external malleolus with that of the *Peroneus Brevis*. It is inserted with the *Extensor Brevis Digitorum* at the base of the fifth metatarsal bone.

*Tibialis Anticus* arises from the outer tibial tuberosity and the tibial tubercle from the anterior tibial crest at its upper third, and from the fascia of the leg. The muscle becomes tendinous at the lower fourth of the shaft of the tibia, and is inserted into the base of the first metatarsal bone. In some subjects a slip arises separately from the interosseous membrane. The muscle receives its nerve-supply from the anterior tibial.

*Extensor Longus Digitorum* arises by a small narrow tendon from a pit on the external condyle of the femur above that for the *Popliteus*. The tendon passes downward parallel with the external lateral ligament, and beneath the fascial insertion of the *Biceps Flexor Cruris*, thence lying in a smooth groove between the head of the fibula and the outer tibial tuberosity it is continuous with the narrow thong of muscular fibre constituting the body of the muscle. The tendons of insertion are formed at the lower third of the tibia, and form a close bundle of rounded cords, that descend to the ankle, at which point they pass through a special loop of the annular ligament to be displayed in a tendon-centre as flat, mutually-supporting bands on the medio-dorsal aspect of the foot. From the distal border of this centre, flat tendons pass to the second and to the fifth toes. The muscle receives its nerves from the anterior tibial at the proximal end.

*Extensor Brevis Digitorum* arises from the outer surface of the calcaneum and the loop of annular ligament for the last-named muscle. A broad, tendinous expanse, aponeurotic in structure,

furnishes the short, broad tendons of insertion (lying beneath those of the long flexor) into the toes from the second to the fourth. It is joined by the *Peroneus Tertius*.

*Extensor Longus Pollicis*.—This was found in one subject only. It arises from the fibula at its upper third.

The intrinsic muscles of the pes embrace the following:—

*Flexor Brevis Digitorum*.—This flat, muscular sheet arises from the intersection between it and the *Plantaris*, as this structure underlies the calcaneum. (See the account of the *Plantaris*.) At the proximal half the muscle is uniformly fleshy. It splits into four slender fascicles. In some specimens the fascicle to the second toe is given off a little higher than the others at the distal half.

Opposite to the metatarso-phalangeal joints, from the second to the fifth, each of the four delicate tendons enters the sheath in common with the corresponding tendons of the *Flexor Longus Digitorum* and by splitting embraces the last-named tendons.

The ends of each split tendon are inserted on the second phalanx. Passing between the tendons of the short and the long flexors are three muscular slips. They arise from the plantar surface of the conjoined tendon. They are inserted respectively into the tendon of the first, second, and third toes.<sup>1</sup>

The *Flexor Brevis Pollicis* is represented by two distinct muscles each ending in a sesamoid. The *Adductor Pollicis* is inserted half way up the lateral border of the second phalanx. According to the terminology of human anatomy, the following would be the arrangement of the Dorsal and Plantar Interossei muscles:—

The first and second Dorsal Interossei are united at the middle by two stout fasciuli. The third Dorsal Interosseous unites with the first Palmar at the distal half of the third metatarsal bone. The fourth Dorsal Interosseous is similarly fused with the second Palmar Interosseous. The third Palmar Interosseous is absent. A small oblique muscle having relations to the second toe similar to those entertained by the *Adductor Pollicis* to the first, is inserted upon the first phalanx of the second toe.

<sup>1</sup> The arrangement of fibres passing from the short to the long flexor of the toes has received special attention from E. Schulze, (*Zeitschr. für wissen. Zool.*, xvii, 1867, 1) who has figured them as they exist in the dog.

Studying these muscles without reference to human anatomy, the arrangement is simple, and the terminology herewith employed much preferable, in my judgment, to that in the foregoing section.

Five Metatarso-Phalangeal Flexors are present in the foot of the *Procyon*. The least differentiated of these is seen in the third muscle of the series. This muscle remains unspecialized as far as the proximal third of the third metatarsal bone. It then divides into two stout fasciculi, each of which goes to the sesamoid bone of its own side. *Procyon*, as *Felis*, possesses a pair of sesamoid bones to each metatarso-phalangeal joint.—The fourth Metatarso-Phalangeal Flexor is essentially the same in plan as is the third.—That of the second toe, however, exhibits almost complete longitudinal cleavage, two short oblique bands alone uniting the now almost distinct muscles. The lateral half of the muscle arises from the sheath of the Peroneus Longus muscle, the median half arising from the under surface of the first cuneiform in common with the lateral half of the first Metatarso-Phalangeal Flexor. The muscle last named is highly specialized, the two halves being distinct throughout, but for a small oblique fascicle at the proximal end of the two muscles, the median arising as above indicated and the lateral from a supernumerary ossicle lying on the plantar aspect of the third cuneiform bone.—The fifth Metatarso-Phalangeal Flexor is, like the first, highly specialized and composed of two non-communicating slips, both of which arise from a supernumerary ossicle in the sheath of the Peroneus Longus.

The median portion of the same sheath sends distally three radiated fasciculi. The median is homologous with the Adductor Pollicis, the remaining two are functionally adductors to the second and fifth toes respectively.

*Opponens Pollicis*.—Under this heading is appropriately included a stout muscular fasciculus passing from the under surface of the astragalus and inserted into the base of the first metatarsal bone.

According to the classification of the intrinsic muscles of the foot, proposed by D. L. Cunningham (*Journ. Anat. and Physiol.*, xiii, 1879, 1), by which palmar adductors, dorsal adductors and intermediate flexors are identified, the muscles in *Procyon* exhibit well-developed palmar adductors and intermediate flexors, while the dorsal adductors are rudimentary or absent.

*Concluding Remarks.*—The tendency for certain muscles, as the Gluteus Medius, the Semimembranosus, the Biceps Cubiti, the Triceps, and the Masseter to undergo partial planal cleavage, *i. e.*, to form distinct laminae at one part, while but a single lamina, embracing the entire thickness of the muscle, at another, indicates that such muscles are imperfectly differentiated, but are yet sufficiently differentiated to receive nerve-supply from separate sources.

In the process by which a muscle-sheet is changed into a muscle-thong or "cord" (premising such a process ever to take place), the sheet is folded once upon itself. The two halves of the sheet constitute the laminae. The space between becomes the inter-laminate space, and receives the nerves. This retention of a muscle-thong with the laminae and interlaminate space as seen in many muscles of *Procyon* would indicate a lower type of muscle than any seen in *Felis*, in which genus the tendency exists for the interlaminate space to become obliterated by the fusion of the laminae. The nerve, however, always enters the muscle at the position of the lines of fusion.

While the changes witnessed in a sheet of muscle undergoing longitudinal *cleavage* are included under the head of progressive development (as is witnessed in the evolution of special slips from the Panniculus Carnosus in the formation of the muscles of the auricle and of the face; and while similar changes are known to occur by which the great vertebro-costal masses send off partially distinct fascicles to various portions of the trunk), those witnessed in the limbs by which distinct laminae in an early form undergo *fusion*, and thereby become complex in a later form, are to be included under the same general head. In that variety of development by which a single muscle is converted into many muscles by a process of splitting, the portions thereby formed can reunite by a process of splicing. The splitting is carried as far in *Felis* as in *Procyon*, but the splicing process is carried farther in *Felis*.

The number of nerves was found to be subject to considerable variation. Muscles of low degree of specialization such as the Latissimus Dorsi, Biceps Flexor and Semimembranosus were found richer in nerves than highly specialized muscles such as the Tibialis Anticus and the Supinator Longus. Between *Felis* and *Procyon* marked contrasts were presented between muscles of the same name—the lowly specialized muscles in all instances

receiving more nerves in *Procyon* than in *Felis*. The number of nerves diminish as a laminated muscle in *Procyon* becomes highly fused in *Felis*. This was well exhibited in the instance of the Biceps Cubiti.

Under the head of muscle-variations it has been seen that many muscles in *Procyon* correspond to abnormal muscles in man. Some of these have been noted in the text. It is equally instructive to note many that are identical with the human muscles, such, for example, as the rotators of the femur. Other muscles in *Procyon* appear to be beyond the limits of variation of human myology. Among the latter group may be named the continuity of the Plantaris and the Flexor Brevis Digitorum, the accession from the Panniculus to the Pectoralis, and the fusion between the Flexor Longus Pollicis Pedis and the Flexor Longus Digitorum Pedis.